Rule CIC275: CICS-DB2 TCBs in use was approaching TCBLIMIT

Finding: The peak number of Task Control Blocks (TCBs) in use for the CICS-DB2 connection was approaching the limit set by the TCBLIMIT attribute.

Impact: With the default guidance settings, the finding is an "alert" of a pending problem. If the TCBLIMIT is reached, there normally would be a MEDIUM IMPACT or HIGH IMPACT on the performance of CICS tasks in the region that use the CICS-DB2 connection.

Logic flow: This is a basic finding, based upon an analysis of the CICS statistics. This finding applies only with CICS/Transaction Server for OS/390 Release 1.2 and subsequent releases of CICS.

Discussion: The CICS-DB2 attachment facility creates an *overall* connection between CICS and DB2. This connection provides CICS applications with access to DB2 data while operating in the CICS environment.

Within the connection between CICS and DB2, there is an *individual* connection into DB2 for each active CICS transaction accessing DB2. This individual connection is called a *thread*. Threads allow each active CICS transaction to access DB2 resources.

There are three types of threads: Command threads, Pool threads, and DB2 Entry threads,.

- Command threads are used by the CICS DB2 attachment facility for issuing commands to DB2 via the DSNC transaction. The maximum number of command threads is specified using the COMTHREADLIMIT attribute of the DB2CONN resource definition.

- Pool threads are used for all transactions and commands that are not using a Command thread (because the transaction is not DSNC), are not using an Entry thread (because an Entry thread had not been defined for the transaction), or have been "overflowed" to the pool because a Command thread or an Entry thread was not available. The maximum number of pool threads is specified using the THREADLIMIT attribute of the DB2CONN resource definition.

- One or more Entry thread categories optionally can be defined (using the DB2ENTRY definition) for specific transactions or groups of transactions. Entry threads are used for transactions that need to be managed separately from the normal transactions, or for transactions that have

special accounting needs. The maximum number of Entry threads is specified using the THREADLIMIT attribute of the DB2ENTRY definition.

Each thread runs under a *thread task control block* (thread TCB) that belongs to CICS. CICS and DB2 both have connection control blocks linked to the thread TCB. They use these connection control blocks to manage the thread into DB2, and to communicate information to each other about the thread.

The TCBLIMIT attribute of the DB2CONN definition specifies the maximum number of TCBs that can be used to process DB2 requests.

- When connected to DB2 Version 5 or earlier, the CICS DB2 attachment facility creates the TCBs in the form of subtasks, up to the limit specified by the TCBLIMIT attribute.

  If TCBLIMIT is reached in this environment, the CICS DB2 task-related user exit must wait until another task stops using a subtask thread TCB, and it can then use the released subtask thread TCB.

- When connected to DB2 Version 6 or later, CICS creates open TCBs (up to the limit specified by the system initialization parameter MAXOPENTCBS). The TCBLIMIT attribute of the DB2CONN definition governs how many of the open TCBs can be used to access DB2.

  In this environment, the TCBLIMIT attribute of the DB2CONN definition controls how many of the L8 mode open TCBs can be used by the CICS DB2 task-related user exit to run threads into DB2.

  If the TCBLIMIT is reached, the CICS DB2 task-related user exit can obtain an open TCB from the pool controlled by MAXOPENTCBS, but it must wait before it can use the open TCB to run a thread into DB2. When another task stops using its open TCB to run a thread into DB2, the number of open TCBs in use falls below TCBLIMIT and the waiting task is allowed to use its own open TCB[1] to run a thread into DB2.

As described above, the TCBLIMIT value controls the total number of threads for the CICS region since a thread cannot be created or used unless there is an available TCB.

Depending on the setting of the THREADWAIT attribute in the DB2CONN definition, transactions can wait for a thread, or can abend if a TCB is not available for thread creation. For transactions assigned to a DB2ENTRY,

[1] However, if MAXOPENTCBS is reached, no more open TCBs are allowed in the CICS region, and the CICS DB2 task-related user exit cannot even obtain an open TCB for its use. It must wait until an open TCB is released by another task and returned to the pool controlled by MAXOPENTCBS, when it can use the released open TCB.

the transactions can wait for a thread, can abend if a TCB is not available for thread creation, or can overflow to the Pool.

- Transaction performance can be poor and erratic if the transactions must wait for a thread.

- If the target of a forcepurge request is queued on a CICS-DB2 ready queue awaiting a DB2 thread or TCB to become available, the target transaction cannot be purged. CICS defers the forcepurge[2] until the target transaction is no longer protected against purge. The TCBLIMIT on either the DB2CONN or the DB2ENTRY must be increased to allow the forcepurge to complete.

- Message DFHDB2010 ("The transaction was abnormally terminated because a DB2 thread TCB was not available on which to create a thread for the transaction") will be issued if transactions are terminated because a TCB was unavailable.

- If Entry transactions overflow to the Pool, they are subject to the attributes of Pool threads (as example, Pool threads cannot be protected, Entry transactions become subject to the THREADWAIT attributes of the Pool which could include being terminated with abend code AD2P, and the PRIORITY of Pool threads likely are different from the PRIORITY attribute of the DB2ENTRY to which the transaction was assigned).

Considering the performance penalties of not having an available TCB to use, there might be an inclination to simply specify a large value for the TCBLIMIT in the DB2CONN definition. However, there can be serious performance implications of specifying a TCBLIMIT value that is too large. As examples:

- **TCBs require storage**. The CICS-DB2 attachment facility attempts to attach a TCB on which a DB2 thread was to be created to service the SQL request from an application. If the attach of the TCB fails due to lack of storage, the transaction is abnormally terminated with a transaction dump.

- **TCBs require processor resources**. The MVS dispatcher must scan the TCBs to identify an active TCB. If there is a large number of TCBs, there could be a significant cost of processor time.

Consequently, there is a trade-off between specifying a sufficiently large number of TCBs and specifying an excessively large number of TCBs. This finding (Rule CIC275) relates to the problem of potentially not having a

[2]Message DFHAP0604 is issued if this should occur.

sufficiently large number of TCBs. Rule CIC275 gives an "early warning" of a performance problem.

CICS-DB2 global statistics are available in MXG file CICDB2GL. CPExpert uses data in CICDB2GL to calculate the percent of TCBs in use relative to the TCB limit, using the following algorithm:

$$Percent\ TCBs\ in\ use\ ' \frac{Peak\ TCBs\ in\ use}{TCB\ limit}$$

where

Peak TCBs in use	=	D2GTCBHW
TCB limit	=	D2GTCBLM

CPExpert produces Rule CIC275 when the percent peak TCBs in use is more than the value specified by the **PCTD2TCB** guidance variable in USOURCE(CICGUIDE). The default value for the **PCTD2TCB** is 80 indicating that CPExpert should produce Rule CIC275 whenever the peak TCBs in use was more than 80% of the TCB limit specified for the CICS-DB2 Connection.

Suggestion: You should consider the following alternatives if Rule CIC275 is produced:

- **Increase TCBLIMIT value**. It normally is not wise to have the TCBLIMIT reached, since serious performance problems could result from tasks waiting for TCB. You can increase the TCBLIMIT value on the DB2CONN definition if you wish to allow more TCBs to be used.

  IBM recommends that the value for TCBLIMIT is the sum of all specified thread limit values (the sum of all THREADLIMIT attributes on the DB2 connection and DB2 entry resource definitions, plus the COMTHREADLIMIT value on the DB2 connection definition).

  If you have a DB2 Version 6 or later environment, please ensure that the MAXOPENTCBS value in the System Initialization Table (SIT) is adjusted as necessary. Message DFHDB2211I will be produced during region start-up if MAXOPENTCBS in the SIT is lower than the TCBLIMIT setting in the DB2CONN definition.

  Please note that if you increase the TCBLIMIT value, you should verify the setting of the CTHREAD parameter of DB2. The CTHREAD parameter might need to be increased.

- **Use transaction class limits**. If you wish to limit the amount of CICS-DB2 activity, you should consider using transaction class limits rather

than using the TCBLIMIT value. IBM states that it is better to limit transactions using a transaction class than allow them to queue for TCBs.

- **Modify guidance**. You can modify the PCTD2TCB guidance variable in USOURCE(CICGUIDE) if you feel that Rule CIC275 is produced prematurely.

Reference: *CICS/TS Release 1.3 CICS DB2 Guide*: Section 5.4 (Creating, using, and terminating threads)

CICS/TS Release 1.3 *Resource Definition Guide*: Section 5.1.3 (DB2CONN)

CICS/TS for z/OS Release 2.2 *CICS DB2 Guide*: Section 5.4 (How threads are created, used, and terminated)

CICS/TS for z/OS Release 2.2 *Resource Definition Guide*: Section 2.3.4 (DB2 connection definition attributes)

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